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SOLDER ALLOY FOR HEAT EXCHANGERS

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SOLDER ALLOY FOR HEAT EXCHANGERS

[Netsukokanki yo handa gokin]

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[There are no amendments to this patent.]

Claims

1. Solder alloy for copper and copper alloy heat exchangers with the characteristic that it consists of 1-15 wt% of Zn and the rest with Sn except for inevitable impurities.

2. Solder alloy for copper and copper alloy heat exchangers with the characteristic that it consists of 1-15 wt% of Zn, less than 3 wt% of Cu, and the rest with Sn except for inevitable impurities.

3. Solder alloy for copper and copper alloy heat exchangers with the characteristic that it consists of 1-15 wt% of Zn, less than 3 wt% of Cu, less than 5 wt% of at least one type or more from Ag, In, Sb, Ni, Fe, and Bi, and the rest with Sn except for inevitable impurities.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention concerns solder alloy for heat exchangers. More specifically, it concerns solder alloy for heat exchangers that is used in building heat exchangers for automobile radiators and car heaters, for example, that are made of copper and copper alloy.

[0002]

Prior art

Pb-Sn type solder materials are generally used in bonding copper and copper alloy heat exchangers. In the field of car radiators and car heaters, binary alloy with 85-35 wt% of Pb is used with the remainder Sn. Those with the Pb content of 85-60 wt% in particular are often used.

[0003]

However, when a heat exchanger that uses solder with a large amount of Pb is disposed outdoors after cutting apart by a shredder or without it, Pb seeps out into the soil, which is an issue in the prevention of pollution. There also is the generation of defects in some cases including leakage when the bonding part between the plate material and the tube material, for example, receives heat stress and has creep deformation and removal of the fin and rupture of the tube, for example, when a severe corrosion that looks like a bloomed flower takes a place by the potential difference between the brass and the solder.

[0004]

Problem to be solved by the invention

The objective of the present invention is to offer a solder alloy for heat exchangers that does not contain Pb, which is the said issue in pollution, and also has excellent strength and creep strength when compared to Pb-Sn type solders, as well as excellent corrosion resistance with a reduced level of electric erosion between brass, and its final purpose is the improvement of the reliability of heat exchangers for car radiators and car heaters, for example.

[0005]

Means to solve the problem

The present invention is based on the knowledge of an itemized selection of the elements that are added for providing wet-expandability to copper and copper alloy by the Sn-based Sn alloy and obtaining an alloy for attaining the aforementioned objective.

[0006]

More precisely, the solder alloy for copper and copper alloy heat exchanges in the present invention has the characteristic of consisting of 1-15 wt% of Zn and the rest with Sn except for inevitable impurities.

[0007]

The alloy for copper and copper alloy heat exchangers in the present invention may also contain less than 3 wt% of Cu in addition to the aforementioned composition.

[0008]

Furthermore, the alloy for copper and copper alloy heat exchangers in the present invention may also contain less than 5 wt% of at least one type or more from Ag, In, Sb, Ni, Fe, and Bi in addition to Cu.

[0009]

Zn has the effect of increasing the strength of the solder alloy and decreasing the fusion point. It also increases the creep strength. The content is 1-15 wt%, preferably at 3-10 wt%. When the content is less than 1 wt%, that effect is not sufficient. The fusion point goes up when the content exceeds 15 wt%, and the wet-expandability and the corrosion resistance also decrease. Furthermore, even if it is added in a relatively large amount, the promotion of the electric erosion with brass in proportion to the electric potential as in Pb is reduced. Zn generally has been considered a harmful element when assuming electronic materials and electric soldering because it uses a weak active flux and has an insufficient wet-expandability when added. However, the wet-expandability decreases slightly when compared to Pb-Sn type because a strong active flux is used in building heat exchangers for car radiators and car heaters, for example; however, it is possible to ensure the wet-expandability at a usable level.

[0010]

Cu has the effect of improving the creep strength and also preventing a phenomenon referred to as solder bite, wherein a fin material, for example, as a material to be bonded fuses into the solder and becomes thin and weak. Therefore, it can be contained optionally. That content is less than 3 wt%, desirably at 0.1-1 wt%. When the content exceeds 3 wt%, the fluidity of the solder material decreases, and it is difficult to use it.

[0011]

Ag, In, Sb, Ni, Fe, and Bi can be optionally contained because they respectively have the effect of improving the strength of the solder material, and In and Bi further improve the wet-expandability. The content is less than 5 wt%. When the content exceeds 5 wt%, the effect will be saturated, and it is meaningless to contain more than that.

[0012]

Application examples

The present invention will be explained specifically, based on the Application examples, etc. below.

<u>Application Examples 1-3 and Comparison Examples 1-2</u>

First, five types of alloys are fusion-prepared as below.

(1) Composition: 8.9 wt% of Zn and the rest is Sn, Fusion point: 198°C (Application Example 1)

(2) Composition: 8.9 wt% of Zn, 0.5 wt% of Cu, and the rest is Sn, Fusion point: 198°C (Application Example 2)

(3) Composition: 8.9 wt% of Zn, 0.5 wt% of Cu, 0.3 wt% of Sb, and the rest is Sn, Fusion point: 198°C (Application Example 3)

(4) Composition: 72 wt% of Pb and the rest is Sn, Fusion point: 265°C (Comparison Example 1)

(5) Composition: Pure Sn, Fusion point: 232°C (Comparison Example 2)

Each aforementioned fusion point is measured from each state in the diagram.

[0013]

Each is casted into a mold from the temperature 100°C higher than that fusion point, a round bar with a diameter of 20 mm is obtained, and a machine test piece, for example, (sample to be provided) is extracted.

[0014]

(1) In the results of the pull test, the tensile strength is 77 N/mm^2 and the stretch is 53% in Application Example 1, the tensile strength is 77 N/mm^2 and the stretch is 49% in Application Example 2, the tensile strength is 78 N/mm^2 and the stretch is 46% in Application Example 3, the tensile strength is 43 N/mm^2 and the stretch is 25% in Comparison Example 1, and the tensile strength is 25 N/mm^2 and the stretch is 55% in Application Example 2.

[0015]

(2) The creep stretch amount is measured under the environment of 130°C by suspending a constant load of 4.7 N/mm^2. The diameter in the load part is 2 mm, and 1.5 mm in the parallel part. In the results, the stretch is 0.26 mm after 67 h in Application Example 1, the stretch is 0.06 mm after 67 h in Application Example 2, and the stretch is 0.04 mm after 67 h in Application Example 3. Both Comparison Examples 1-2 broke within 67 hours.

[0016]

(3) A brass plate with 70 wt% Cu and 30 wt% Zn coated with 0.4 mL of flux that consists of saturated $ZnCl_2$ solution and 0.3 g of solder metal or alloy (sample to be provided) is mounted. Over the Sn-Pb bath that has the temperature established at 50°C higher than the fusion point, and the wet-expandability is examined. Comparison Example 1 has the best wet-expandability, however, all solder metals and alloys have a satisfactory wet state.

[0017]

(4) The lower 3 x 3 cm half of four 3 x 6 cm brass plates is fusion-plated with each solder metal or alloy (samples to be provided) in Application Examples 1-3 and Comparison Examples 1-2, and each brass plate is individually immersed and soaked in a 5% NaCl solution for 90 h. After the test, the solder metal or alloy is washed with a 10% sulfuric acid, and the corrosion decrease amount is obtained. The corrosion decrease amount in Application Example 1 is 30 mg, 31 mg in Application Example 2, 30 mg in Application Example 3, 50 mg in Comparison Example 1, and 26 mg in Comparison Example 2. A significant amount of a white precipitate deposit was observed in the bottom of the beaker in which Comparison Example 1 soaked.

[0018]

(5) 2 brass pieces with a 1 cm square laminated joint are prepared by soldering solder metal or alloy in Application Examples 1-3 and Comparison Examples 1-2. The soldering condition includes holding at the temperature of the fusion point +50°C for 15 min, which is the condition for the alloy layer to develop. The pull separation strength is examined by pulling both ends of the brass by a pull-tester. The physical definition is difficult to make because the strength obtained has the soundness of the alloy layer, shear strength of the solder alloy, and the wet area, etc., mixed together. However, in the results, it is 1700N in Application Example 1, 2010N in Application Example 2, 2050N in Application Example 3, 1690N in Comparison Example 1, and 1980N in Comparison Example 2.

[0019]

Effect of the invention

As explained above, the Sn alloy solder in the present invention has excellent strength and creep strength, and has a reduced amount of corrosion with brass by electric erosion. It also does not contain Pb, therefore, it does not cause pollution by Pb when used in heat exchangers of car radiators and car heater, for example, and it can offer a heat exchanger with improved reliability because it is difficult for it to have an accident like water leakage, for example.